Form ESA-B4. Summary Report for ESA-140-3
Public Report - Final

Company	United States Steel Corporation	**ESA Dates**	Aug 11-13, 2008
Plant	Clairton Plant	**ESA Type**	Pumping Systems
Product	Coke	**ESA Specialist**	Glenn Cunningham

Brief Narrative Summary Report for the Energy Savings Assessment:

Introduction:
The Clairton Plant is located approximately 20 miles south of Pittsburgh in Clairton, Pa., and sits along the west bank of the Monongahela River. The largest coke manufacturing facility in the United States, the Clairton Plant operates 12 coke oven batteries. The Clairton Plant produces approximately 4.7 million tons of coke annually and serves customers in the commercial coke market as well as U. S. Steel's steelmaking facilities.

The pumping assessment focused on two pumping systems: 1) River water supply system; 2) Treated water booster pumps.

Objective of ESA:
To introduce the US DOE PSAT and Valve software tools to plant personnel and use the tools to identify energy saving opportunities related to the plant pumping systems.

Focus of Assessment:
Plant's pumping systems and US DOE pumping software tools.

Approach for ESA:
- Learned PSAT & Valve Tool Software
- Reviewed pumping system fundamentals
- Analyzed 2 Plant Pumping Systems
  River water Supply pumps
  Treated water booster pumps
- Proposed several projects for further study
- Measured power, rotational speed and pressures on multiple pumps

General Observations of Potential Opportunities:
- Indicate total plant natural gas consumption for base year, 2007: 824,880 MMBtu
- Indicate total plant electricity consumption for base year, 2007: 334,926,000 kWh

- ❑ Near Term Opportunities: There were no near term opportunities identified during this assessment.
- ❑ Medium Term Opportunities:

<u>River Water Supply Pumps</u>
There are 6 pumps used to move water from the river to a 145 foot tall stand tank that provides cooling water to the plant. Five of the six pumps have 1,500 hp motors and the sixth pump is "1/2 sized" with a 800 hp motor. The full sized pumps operate at about 21,500 gpm at 184 feet of head (determined from the pump curve and the measured flow rate), depending on the number of pumps in operation. The "1/2 pump" is sized for about 17,500 gpm at 160 feet of head. The stand tank has two headers, east and west, supplying water from these pumps. During much of the summer the cooling water demand from the plant is low enough that two "1/2 pumps" could handle the service. Currently in the summer, during times of reduced flow rates, one large pump operates heavily throttled with a gate valve located at the

pump discharge and the "1/2 sized pump is also used. Based on pressure measurements made during the assessment on the system it is estimated that 68.3 feet of head is being lost across the throttling valve with a flow of 21,500 gpm. The installation of a second "1/2 sized" pump would allow this throttling loss to be eliminated. The current pumping efficiency is estimated at 83.5% and a new pump properly selected should operate with an efficiency close to 93.0%. The PSAT analysis of this recommendation is shown in Figure 1 below. The current condition for the summer operation of one of the large pumps predicts an operating cost of $247,100 for 6-month at an electrical cost of $0.060/kWh. Under Condition B, the optimized cost for 6-month operation with a new pump is $139,300, saving $107,800 per year. The estimated cost of replacing this pump is about $100,000, resulting in a simple payback of 0.93 years. The existing 1,500 hp motor could be used to drive the new pump. The motor efficiency does not decline much as load drops until the load is reduced to below 35% or so. Power factor correction capacitors should be considered for addition to the motor as operating a motor at 50% load will cause the power factor to decline significantly from its full load value.

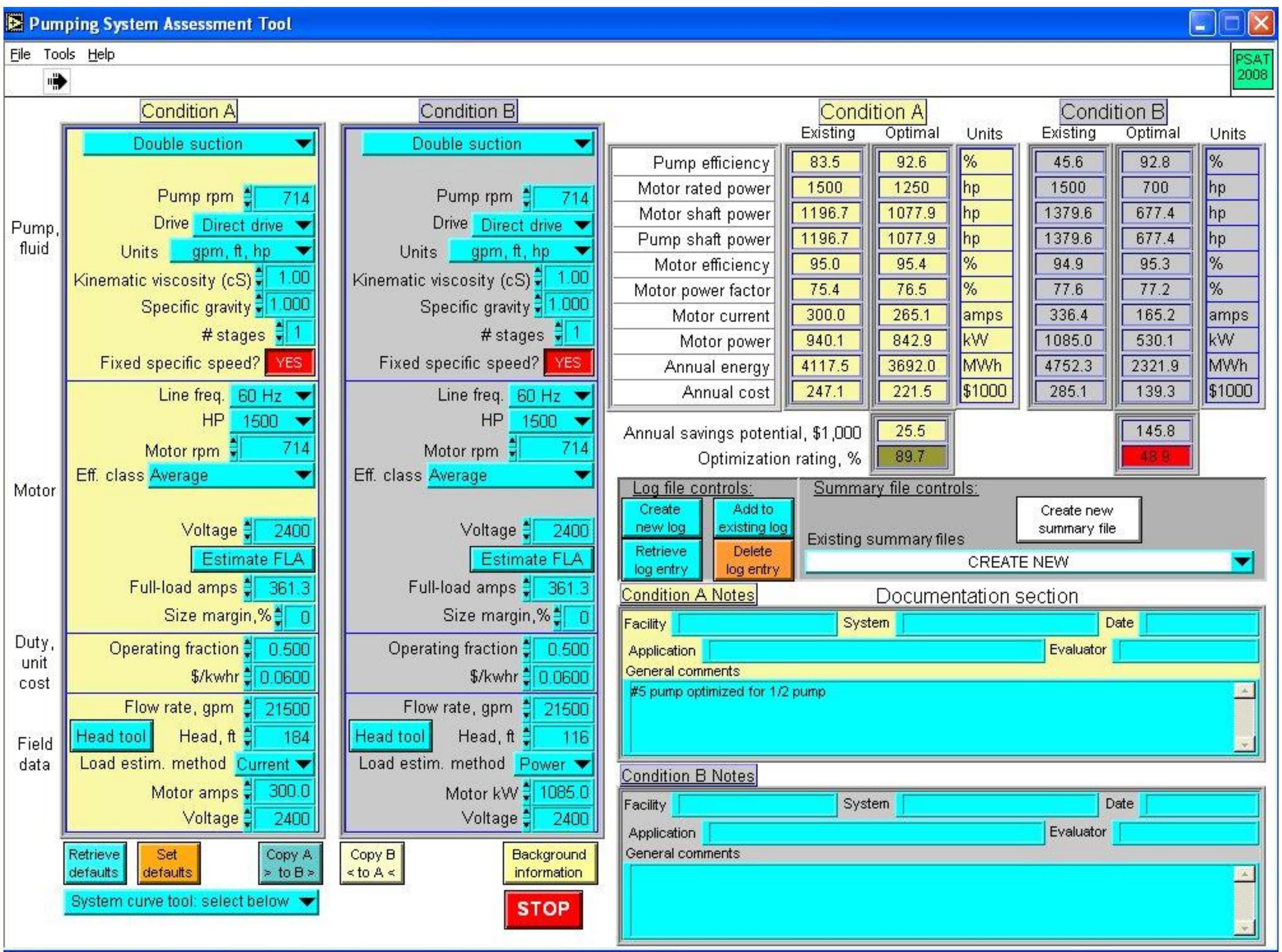

Figure 1. PSAT Analysis for Replacing Large River Water Pump

The pump and system curves are shown below in Figure 2.

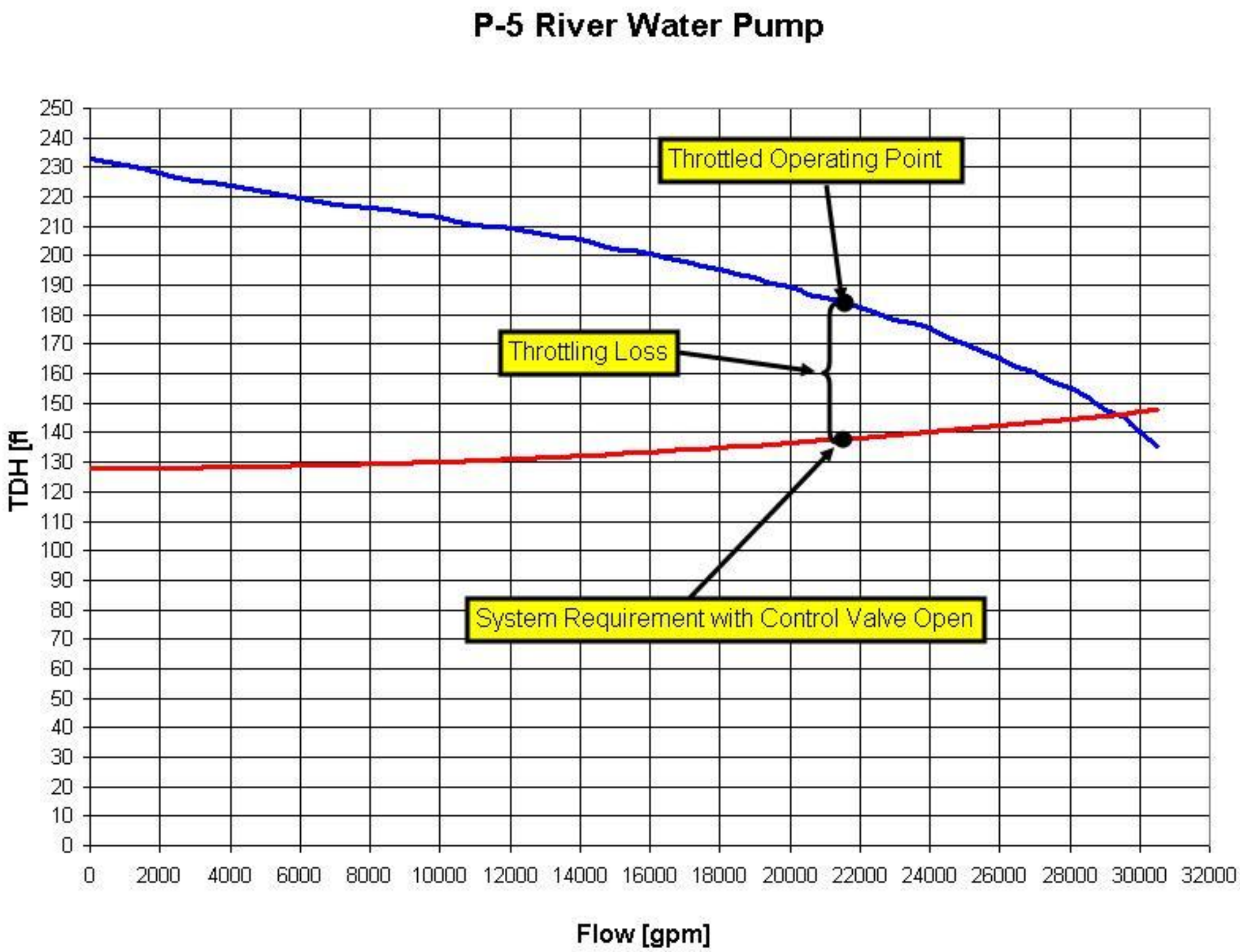

Figure 2. Pump and System Curve for Pump #5

<u>Treated Water Booster Pumps:</u>
The treated water booster pump system is comprised of 4 identical pumps, two with electric motors and two powered with steam turbine drives. Normal operation has two pumps in use, one motor driven and the other with a steam turbine drive. The pumps are operating in a heavily throttled condition causing poor pumping efficiency. Each pump is rated for 3,000 gpm at 160 feet of head. Two pumps are operated to assure adequate flows to the steam system should one pump fail. Required flow rates range from about 1,800 gpm to 2,930 gpm. With this range of flow rates it should be possible to operate just one pump and reduce the throttling losses across the control valves. Not only will energy be saved, but maintenance costs for the control valves and pumps will be reduced. It is reported that cavitation sometimes occurs at the discharge side of the control valves. When this condition exists the pressure drop across the control valve will be larger that expected and the valve will be damaged.

The recommended condition is to operate just one of the turbine driven pumps and install controls to automatically start a motor driven pump if additional flow is needed. These controls can monitor the water level in the deaerator as well as pressures in the pumping system to determine when an additional pump is needed.

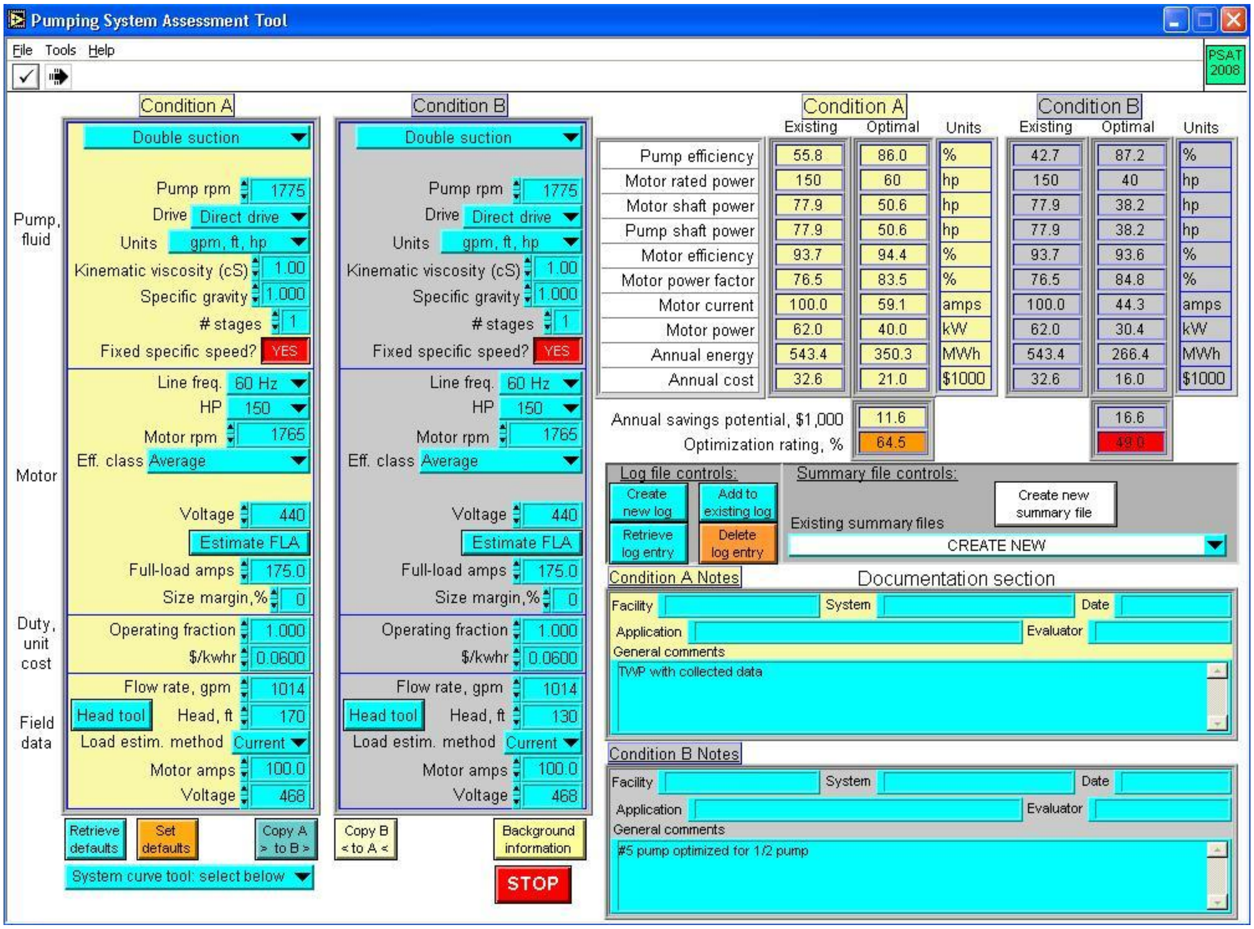

Figure 3. PSAT Model of One Electric Motor Driven Treated Water Booster Pump

The throttling loss across the valve can be evaluated with knowledge of the valve characteristics and the Valve Tool provided with the PSAT program. Information relating valve size, position and flow rate was obtained from Don Casada for the Fisher V150 ball valve used in this application for flow control. After obtaining a valve C_v of 490 for a 10" valve 50% open with a flow of 1,010 gpm, the Valve Tool was used to show the value of the energy dissipated across the valve. The curve of valve C_v versus position is shown in Figure 4 below and the Valve Tool analysis is shown in Figure 5.

The calculated savings for changing to the operation to a single steam driven pump instead of two pumps operating heavily throttled are $31,820 annually. The estimated cost is $30,000, giving a simple payback of 0.94 years.

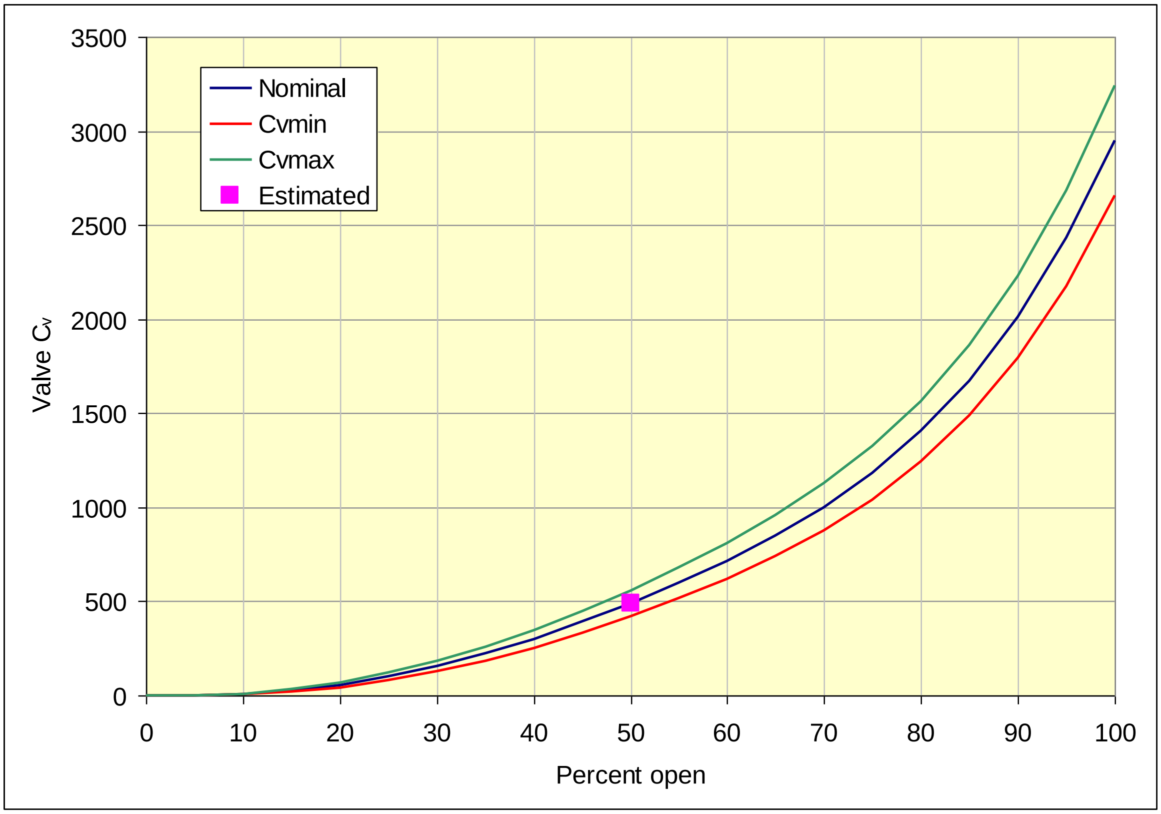

Figure 4. Fisher V150 Control Valve C_v versus Valve Position

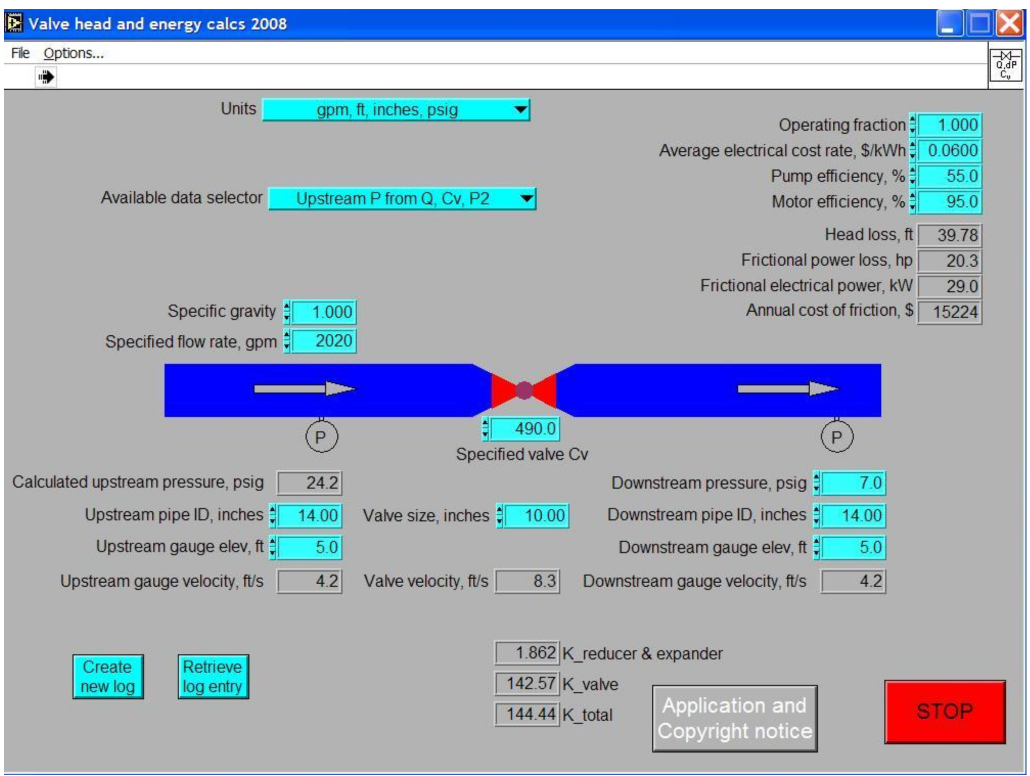

Figure 5. Valve Tool Analysis of Energy Loss Across Fisher V150 Control Valve

- There were no long term opportunities identified during this assessment.

- Estimate, if possible, the identified % plant fuel savings from a) Near Term opportunities: 0%; b) Medium Term opportunities: -0.069%, c) Long Term opportunities: 0%.

- Estimate, if possible, the identified % electricity savings from a) Near Term opportunities: 0%; b) Medium Term opportunities: 0.729%; c) Long Term opportunities: 0%.

Management Support and Comments:
Plant and corporate management is very committed to improving the energy efficiency of this facility. Staff preparation for the Pumping Assessment was excellent, with PSAT software downloaded and explored prior to the assessment.

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